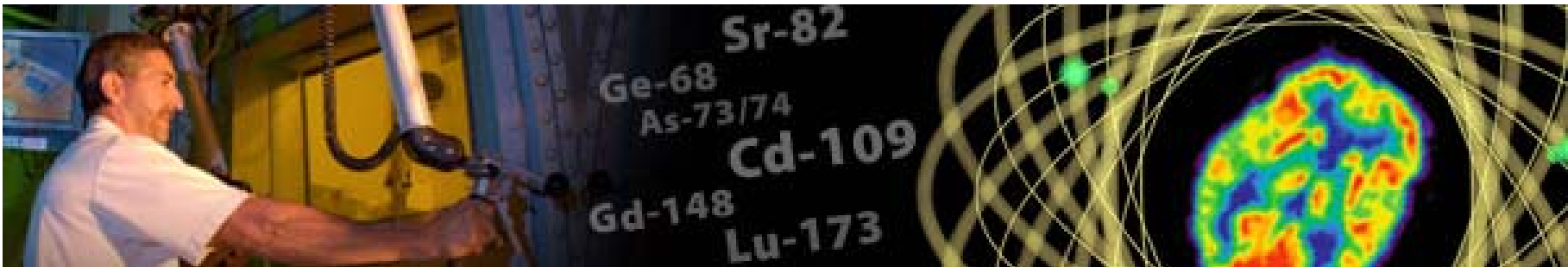




U.S. DEPARTMENT OF
ENERGY

OFFICE OF
SCIENCE

Status of Isotope Program Office of Nuclear Physics



NSAC

March 2, 2011

Jehanne Gillo

***Division Director, Facilities and Project Management
Office of Science, U.S. Department of Energy***



Isotope Program Mission

The mission of the DOE Isotope Program is threefold:

- Produce and/or distribute radioactive and stable isotopes that are in short supply, associated byproducts, surplus materials and related isotope services.
- Maintain the infrastructure required to produce and supply isotope products and related services.
- Conduct R&D on new and improved isotope production and processing techniques which can make available new isotopes for research and applications.

Isotope Program

- Transferred from the Office of Nuclear Energy to NP with the 2009 Appropriation.
- Continues to produce, process, package and deliver isotopes for those isotopes not produced commercially.
- Re-established research and development of isotope production techniques and the production of research isotopes
- Serves a broad community of Federal agencies in addition to DOE—NIH, NIST, EPA, NNSA, DHS...
- Funding is from a combination of appropriations and sales—funds are deposited into the revolving fund which is externally audited annually.

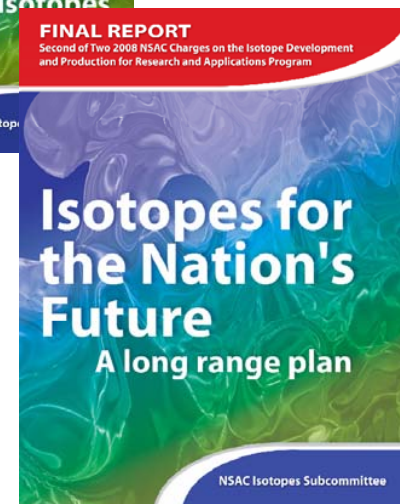


OAK

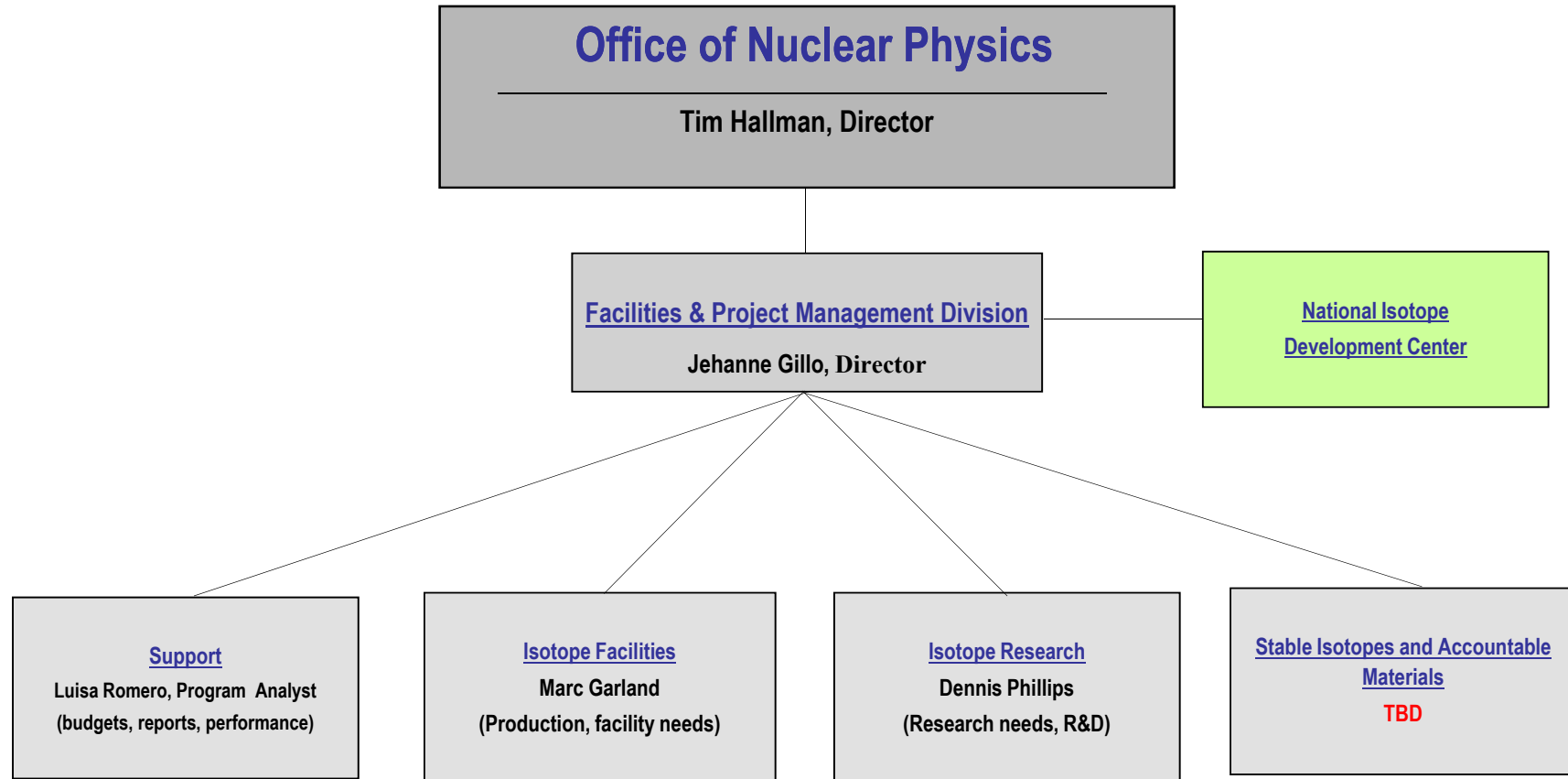
Re-organizing the Isotope Program

The changes to the program have been substantial

- Created Research and Development Program for new and improved isotope production techniques
- Introduced peer review into mode of operations
- Restructured the federal organization of the program
- Created the National Isotope Development Center
- Charged NSAC to set priorities for research opportunities and to develop a long-term strategic plan for isotope production and development.



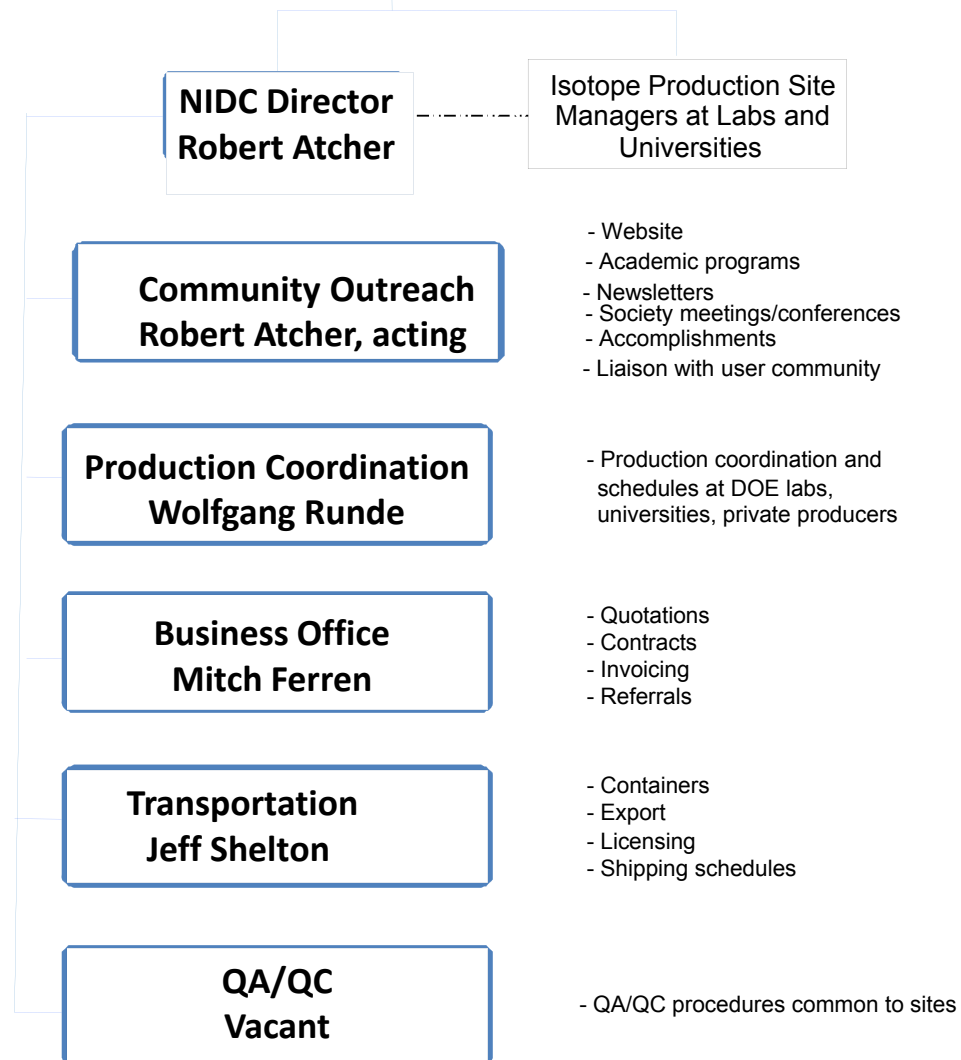
New Isotope Program Organization





**Office of Nuclear Physics Isotope
Production and Applications**

**New
National
Isotope
Development
Center
Organization**





NSAC Research Isotope Recommendations

Compelling Research Opportunities using Isotopes

- Invest in new production approaches of alpha-emitting radionuclides, e.g. Ac-225, At-211.
- Invest in coordination of production capabilities and supporting research.
- Produce isotopes of the heavy elements, e.g. Cf, Ra, TRU.
- Focused study and R&D on new or increased production of He-3.
- Re-establish domestic production and supply of stable isotopes.
- Robust investment into education and training.



Isotope R&D

Initiated R&D effort on the development of new and improved isotope production techniques for research and applications in FY 2009; guided by NSACI recommendations

- **FY 2009 FOA and FY 10 awards**
 - Awards: \$15.2 M in FY 2009 and 2010
 - ARRA Funds: \$8.6 M
 - 10 Laboratory Grants
 - Program funds FY09: \$3.6 M
 - 4 Laboratory; 6 University; 1 industrial
 - Program funds FY10:: \$3.0M
 - 1 Lab; 3 University
 - Alpha emitters (At-211, Ac-225)
 - Diagnostic dosimetry for therapeutic agents (Cu-64, Y-86)
 - Therapeutic (Cu-67)
 - Educational programs/development
 - Stable isotope enrichment
- **FY 11 IDPRA Research FOA (DE-FOA-0000448)**
 - Deadline April 18
 - Up to ~ \$3M in FY11 and same in FY 12



Alpha-Emitter Production for Targeted Radiotherapy

■ Actinium-225

- Continue to process the Th-229 for Ac-225; up to about 360 mCi per year.
- ORNL is conducting R&D to assess alternative accelerator and reactor methods for the production of parent-isotopes for alpha-emitting radionuclides (Th-229, Th-228, Ac-227, Ra-228) . ORNL is also assessing the use of ionic liquids as solvents for improved production of radioisotopes.
- LANL is conducting R&D to provide excitation function data for proton accelerator-based direct production Ac-225.
- R&D conducted by NorthStar is being supported for production of Ac-225 via high energy proton induced spallation.

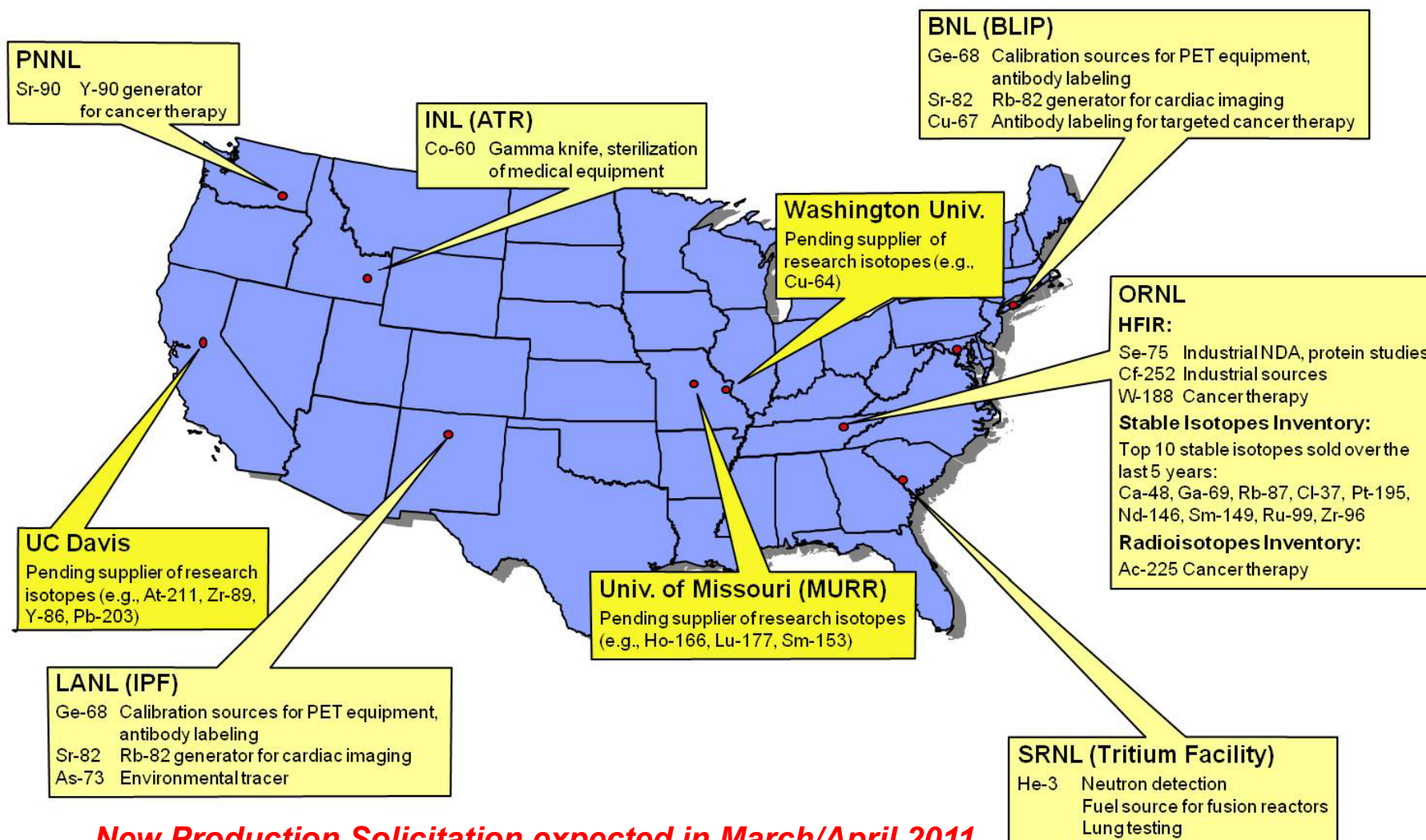
■ Actinium-227

- R&D to separate and purify Ac-227 from surplus actinium-beryllium neutron sources at ORNL and other from legacy Ac-227 at PNNL. When completed, the Ac-227 can be used as a source (cow) for the decay production of very high purity Th-227 and Ra-223, important alpha-emitting isotopes for medicine.

■ Astatine-211

- R&D effort to obtain methods and materials at the University of Washington to routinely supply radiopharmaceutical grade At-211 to researchers.

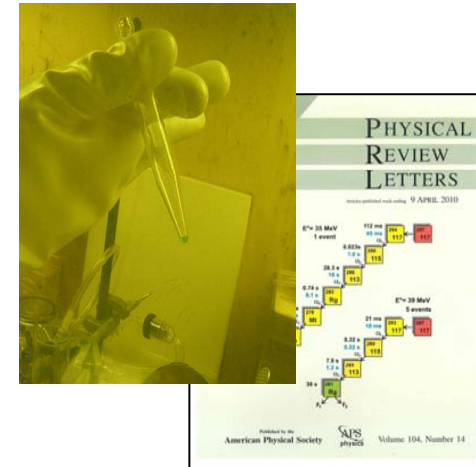
Invest in coordination of production capabilities and supporting research



New Production Solicitation expected in March/April 2011

Produce Elements of the Heavy Isotopes

- NP is the sole provider of research isotopes for super heavy element discovery research
 - 22 mg of berkelium-249 produced as by product of californium production for collaborative experiment between U.S. and Russia leading to the discovery of element 117
 - NP is supporting production of ~ 25 mg of Bk-249 for follow-up search to discover element 119 and 120
- Established reliable supply of Cf-252 for Nation
 - Supplies 97% of domestic market
 - Developing plan for ensuring feedstock supply of curium, including some acquisition
- Re-establishing domestic Am-241 production for industry and research





Focused study and R&D on new or increased production of He-3

■ Helium-3 Shortage

– Established Integrated Project Team in March 2009

- Working Groups: Demand, Supply, Alternative Technologies (neutron detection); and Policy.
- Guided by the steering group chaired by the EOP National Security Council.
- Prioritized and allocated some He-3 in FY 2009; FY 2010 and FY 2011.
- In June 2009 a He-3 workshop to explore alternatives to He-3 for neutron detection technologies was hosted by the Savannah River National Laboratory on behalf of the NNSA Network of Senior Scientists.

– Strategy to Reduce/Manage Demand

- Pursue and employ alternative technologies for neutron detection. American Association for the Advancement of Science (AAAS) workshops: <http://cstsp.aaas.org/Helium3.html>.
- Prioritize use of the existing supply of He-3.
- Prioritize upcoming projects that would be big users of He-3.

– Increase Supply

- Seek He-3 supply from foreign countries.
- Encourage He-3 recycling and reuse.
- Investigate techniques to increase He-3 extraction efficiency.
- Possible new He-3 production.



Re-establish domestic production and supply of stable isotopes

- **Stable Isotope Purchase**

- ORNL stable isotope purchase to replenish inventory of research isotopes such as Lu-176, Mo-100, Ni-62, W-186, and others.

- **R&D Concepts for Modern Stable Isotope Separation Technology**

- ORNL is conducting R&D on technology for integrating gas centrifugation and electromagnetic isotope separation for preparation of stable isotopes.
- New concepts in Plasma Enrichment
- Other concepts for smaller scale enrichment of specific isotopes (e.g V-51) for research
- Open competition for proposal is planned for the future



Education in Nuclear Chemistry and Radiochemistry

- **Collaborative project between LANL and the University of Missouri to do research in the production and application of radioisotopes**
 - Gives undergraduate, graduate, and post-doctoral opportunities to use unique isotope facilities at MURR and LANL
 - Production Se-72/As-72 generator system and synthesis of potential As-72 labeled radiopharmaceutical agents
 - Production and separation of medically useful lanthanide radioisotopes (Gd-153, Nd-140)
- **Project at Pennsylvania State University to support re-establishment of a thriving graduate program in nuclear and radiochemistry**
- **Summer Schools in Nuclear Chemistry and Radiochemistry**
 - NP provides funding to ACS DNCT to support the schools at San Jose State and Brookhaven National Laboratory
 - Isotope Program facilities and staff are used extensively in the program at Brookhaven National Laboratory
- **Sponsoring and Participating in Symposia in Isotope Production and Applications and Radiochemistry Education**
 - Symposium in Division of Nuclear Chemistry and Technology: American Chemical Society Fall National Meeting, Boston, August, 2010
 - IMI Sub-topical meeting of the American Nuclear Society, Las Vegas, November, 2010
 - 7th Symposium on Targeted Alpha Therapy, Berlin, July, 2011



NSAC Long Range Plan Recommendations

Isotopes for the Nation's Future A Long Range Plan

- **Maintain a continuous dialogue with all interested federal agencies and commercial isotope customers to forecast and match realistic isotope demand and achievable production capabilities.**
- **Coordinate production capabilities and supporting research to facilitate networking among existing DOE, commercial, and academic facilities.**
- **Support a sustained research program in the base budget to enhance the capabilities of the isotope program in the production and supply of isotopes generated from reactors, accelerators, and separators.**
- **Devise processes for the isotope program to better communicate with users, researchers, customers, students, and the public and to seek advice from experts.**
- **Encourage the use of isotopes for research through reliable availability at affordable prices.**
- **Increase the robustness and agility of isotope transportation both nationally and internationally.**
- **Invest in workforce development in a multipronged approach, reaching out to students, post-doctoral fellows, and faculty through professional training, curriculum development, and meeting/workshop participation.**
- **Construct and operate an electromagnetic isotope separator facility for stable and long-lived radioactive isotopes.**
- **Construct and operate a variable-energy, high-current, multi-particle accelerator and supporting facilities that have the primary mission of isotope production.**

Improved Communication

- **Workshop held August 5-7, 2008: The Nation's Needs for Isotopes: Present and Future**
 - Assembled representative stakeholders- federal, research and industrial to identify needs and challenges.
- **Establishing links of communications with federal agencies to understand needs and priorities**
 - Federal Working Group to discuss medical isotopes etc.
(DOE BER, DOE NP and NIH); establishing NIH prioritization mechanism
 - EOP Interagency Working Group to discuss He-3: NP/NNSA/DOD/DHS/CIA/FBI/Navy/Commerce/others
 - Solicits input from community in terms of needs
 - OSTP Working Group on Mo-99
- **Charged NSAC to set priorities for research opportunities and to develop a long-term strategic plan for isotope production and development.**
- **National Isotope Development Center to improve public relations with stakeholders**
- **Involved in DOE strategic planning of accountable materials; frequent meetings with NNSA, NE**
- **Both DOE NP and NIDC hosting meetings with industry**
- **Planning a Federal Workshop in 2011 to identify long term agency needs**

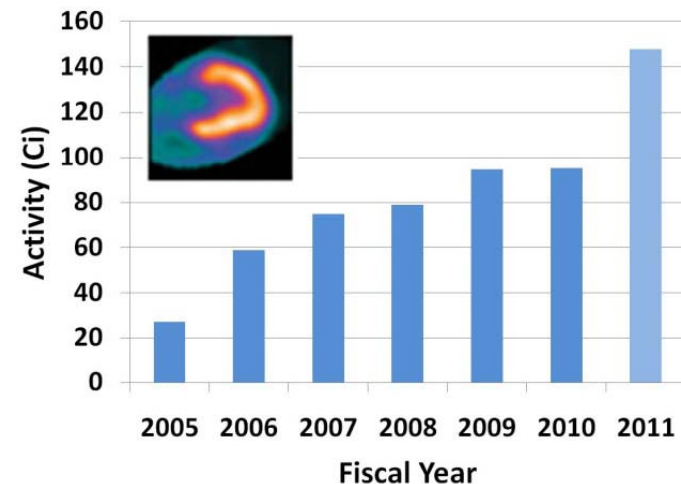


Availability of Research Isotopes

- Actinium-225
 - Arsenic-72
 - Arsenic-73
 - Berkelium-247
 - Beryllium-7
 - Bromine-86
 - Californium-252
 - Copper-64
 - Copper-67
 - Holmium-166
 - Iron-52
 - Lead-203
 - Lutetium-177
 - Magnesium-28
 - Samarium-153
 - Selenium-72
 - Silicon-32
 - Radium-223/Th-227
 - Rubidium-83
 - Tungsten-188/Rhenium-188
 - Yttrium-86
 - Zirconium-89
- Pricing policy has been revised: Unit cost instead of batch cost
 - Additional subsidization
 - Bottom-up cost estimates
 - Base research program at ORNL, LANL and BNL have been established

Other Isotopes

- **Actively working on/considering making other isotopes available in FY11**
 - High specific activity Gd-153
 - Ir-192
 - U-234
 - Am-241
 - Moving Co-60 production from INL to IP
 - Np-237
 - U-233
 - Sr-89
 - Additional quantities of Ra-226
 - Additional quantities of Ac-225
 - NP is Increasing strontium-82 (Sr^{82}) production for cardiac imaging in response to molybdenum-99 supply challenges
 - DOE supplies ~ 75% of domestic Sr^{82} market



Dedicated Facility

- Current two facilities stewarded primarily operate in parasitic mode
- NAS and NSAC both recommended dedicated facility
- Landscape is quickly changing
- Other Commercial entities are planning to build dedicated cyclotron facilities
- Isotope Program is being successful in broadening suite of facilities in cost-effective manner
- NP is encouraging development of proposals
- Multi-energy, Multi-particle Accelerator for radioisotope production (Conceptual Development)
 - ORNL: C70 Driver Cyclotron for radioisotope production and nuclear physics.
 - BNL: C70 Cyclotron for dedicated radioisotope production.
 - LANL: Run IPF at 40 MeV, 70 MeV, 100 MeV; MTS at 800 MeV.
- Considering partnerships with industry
- Need to complete cost-benefit analysis and study of potential business models
- Call for letters of interest anticipated in the summer